LIVESTOCK-RELATED PROBLEMS ON RAPA NUI; ASSESSMENT AND PROPOSED MITIGATION STRATEGIES

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Severe inadequacies exist in the veterinary care and welfare of the animals of Rapa Nui. The most marked problems are livestock overpopulation and the widespread toxicity of horses and cattle associated with ingestion of pyrrolizidine alkaloids in the plant, *Crotalaria grahamiana*. The endemic toxicosis is compounded by pervasive malnutrition, dehydration, parasitism, and antiquated notions of herd management. Intoxicated livestock wander the island searching for sustenance, resulting in progressive damage of precious archaeological sites. Environmental impact of the foraging livestock creates conflicts of interests among ranchers, archaeologists, and the tourism industry. Human public health threats associated with animal-transmitted disease are present in tuberculosis, toxoplasmosis, parasitic larvae migration, and toxic alkaloid ingestion. Mitigation of these conflicts is possible through education, plant eradication, and provision of nutritional support and basic veterinary services. Currently there are no programs or facilities to address these deficits. Any plan aimed at mitigating the current situation must be comprehensive and structured towards balancing the needs of ranchers, the vulnerability of the island's ecosystem, and the importance of the islands archaeological sites. Recommendations towards meeting these goals are presented in this paper.

INTRODUCTION

Documenting a history of animals on Rapa Nui is at least as complex as detailing the history of the island's human inhabitants or the *moai*. In keeping with the mystique of Rapa Nui, the particulars of when, and from where specific animal species were introduced are uncertain at best. In 1722, Roggeveen described the islanders as subsisting on cultivated crops and seafood, and made no mention of domesticated animals. Livestock and companion animals most likely first arrived with the European expeditions of the late 18th and early 19th centuries. The sheep industries of Dutrou-Bornier, Merlet and S. Williamson Company in the late 19th and 20th centuries are well documented, and it is likely that all used livestock for draught and sustenance.

Today, all animal species on Rapa Nui reflect mixed pedigrees. Cattle breeds are mostly crosses of overo negro, Hereford, and several Asian breeds; horses show contributions from thoroughbreds, arabians, criollos, and various pony breeds. Despite the strong emotional bonds that many islanders have to their animals, animal health and welfare on Rapa Nui are largely overlooked or inadequately addressed. he most significant problems among the animal inhabitants are overpopulation and a widespread neurological syndrome resulting from ingestion of alkaloids produced by the introduced plant *Crotalaria grahamiana*.

The 1998 census from the Chilean Ministry of Agriculture (SAG) indicated that the island's 2700 residents own 2576 cattle and 622 horses. However, our recent survey (Arzt et al., n. d.) suggests that both species are present in greater abundance. Additionally, it is estimated that 1500 dogs, 1000 cats, and 2500 chickens are present on Rapa Nui; official statistics are not available for these species. At present, no veterinary care is available on the island.

PYRROLIZIDINE ALKALOID TOXICOSIS

In a recent survey of 28 Rapa Nui ranchers, participants indicated that the most significant health problem among their animals was a fatal syndrome of wasting and neurological dysfunction affecting their horses and cattle (Arzt and Mount, n. d.). Though locals referred to the syndrome as "mad horse and cow disease", the true etiology was recently proven to be intoxication with pyrrolizidine alkaloids (PAs), a class of naturally occurring toxins found in two plants on the island, *Crotalaria grahamiana* (local name, *cho cho*) and *Crotalaria pallida* (local name, *Nga ehe ehe*) (Zizka 1991) *Crotalaria grahamiana* was introduced to control roadside soil erosion prior to 1982.

Crotalaria Graham (cho cho) in flower (above) and along the road near Rano Raraku.

Pyrrolizidine alkaloid (PA) toxicosis has been described in several nations (Mattocks 1986). In the western United States, toxicity in livestock is most commonly associated with ingestion of *Senecio jacobaea* (tansy ragwort) and *S. vulgaris*

(common groundsel) (McLean 1970). Other genera of plants known to contain PAs include *Crotalaria* (rattlebox), *Amsinckia* (fiddleneck), and *Heliotropium* (heliotrope). A plant may produce up to six distinct PAs; toxicity varies among different PAs. Plants containing PAs are thought to be poorly palatable to livestock, and are typically ingested when other forage is unavailable. Human PA-toxicosis has resulted from ingestion of a wide variety of herbal medicinals (Stickel et al. 2000). Though PAs are detectable in the milk of intoxicated animals, it has not been demonstrated that significant toxicosis results from ingestion of this milk (Mattocks 1986).

Ingested PAs are converted into toxic pyrroles in the liver of mammals. The pyrroles then kill liver cells by binding to DNA and proteins involved in cell division (Mattocks 1986). Intoxication typically results in cirrhosis (chronic liver failure), however the toxins also induce renal and pulmonary pathology. The characteristic stuporous behavior of PA-intoxicated animals is a manifestation of hepatic encephalopathy (secondary brain toxicity resulting from inability of the liver to clear endogenous toxins from the blood). The specific pathophysiology of hepatic encephalopathy is not completely understood, however the metabolic byproducts, ammonia and mercaptans, are thought to be among the agents directly responsible for altered neurological function. Though all mammals are susceptible to the toxins, sheep and goats can tolerate up to 200 times greater quantities of ingested PAs relative to horses without showing clinical signs of disease. By the time animals begin to manifest symptoms of intoxication, permanent damage has been done, and death is nearly inevitable (Craig et al. 1991; Mattocks 1986).

Pyrrolizidine alkaloid intoxicated mare near Poike.

The causal relationship between *Crotalaria* ingestion and Rapa Nui mad horse disease was confirmed through several types of scientific analyses performed subsequent to two field investigations conducted in 1999 (Arzt et al., n. d.; Arzt and Mount n. d.). The two species of *Crotalaria* collected on Rapa Nui, *C. grahamiana* and *C. pallida* were found to contain three and two distinct PAs, respectively. Clinical symptoms of the syndrome were first observed approximately 20 years ago, coincident with introduction of *C. grahamiana* to the island.

Incidence of the syndrome was greatest in summer, temporally coincident with the observation of increased frequency of *cho cho* ingestion. Blood chemistry compared between affected and healthy horses revealed statistically significant differences in six parameters used to assess liver damage. Necropsies performed on seven severely affected horses all revealed gross and microscopic changes of horses' livers and kidneys consistent with those seen in previous descriptions of PA toxicosis. Analysis of stomach contents of affected horses identified the same PAs found in *C. grahamiana*.

Mean incidence of the neurological syndrome for the five years preceding the survey was 17 ± 8 % among horses and 14 ± 9 % among cattle. The greatest loss per year occurred when one rancher lost 47% of his horses in a single year. The case fatality (total deaths from the disease ÷ total animals that are affected by the disease) for horses was 98% for the five-year period.

The syndrome among cattle differs somewhat from that seen in horses. All ranchers raising cattle in the Rano Raraku and Poike sectors (40% of the island's herds) reported substantial death losses from an acute neurological syndrome similar to that affecting the island's horses. This is consistent with the fact that in other reported epidemics and clinical trials examining PA toxicosis, cows typically experience a more rapidly progressive form of the disease relative to horses. Currently, definitive diagnosis of PA-toxicity has not been proven in cattle on Rapa Nui.

Environmental and Archaeological Ramifications

The scarcity of adequate feed causes animals to wander in search of sustenance and to ingest unpalatable toxic plants. Ingestion of toxic plants leads to mental deterioration, which then leads to further wandering. These factors combined with overpopulation of horses and cattle on Rapa Nui lead to greater mean daily range mileage per animal. The paths of free-ranging animals scar the island's delicate landscape. Inevitably, livestock graze archaeological sites resulting in erosion of plaza regions, dislodgement of *poro* (beach cobbles) from ramps, and trampling of petroglyphs.

Though the impact of livestock movement can be detected virtually anywhere on the island, the Rano Raraku region is of particular concern. Large numbers of animals come to the crater due to paucity of potable water elsewhere on the island. Marked animal-induced erosion is apparent on the entrance path to the crater and along the footpaths within and along the exterior of the crater. Additionally, horses are frequently seen grazing the plazas of Ahu Tongariki, Ahu Akivi, and Ahu Tahai.

Specific Proposed Projects

The problems involving animals on Rapa Nui are complex. From the veterinarian's perspective, the first problem to be addressed is the profound and widespread animal suffering and neglect. Addressing solely the veterinary concerns (toxic plants, inadequate feed and water) would improve animal health, lead to increased populations, and thus exacerbate the ecological and archaeological problems. Though the animal welfare issues must be addressed, any plan aimed at mitigating the animal suffering must be comprehensive in its consideration of the ramifications of altering the balance of animals and resources. The proposals that follow vary in importance and feasibility. Projects developed from these proposals will be instituted in a coordinated manner to provide satisfaction to the various interested parties.

1. Education: Herd management on Rapa Nui is minimal

to non-existent. To the author's knowledge, neither veterinary nor animal husbandry practices have ever been properly taught to the island's private ranchers. Most ranchers have three injectable veterinary medications in their possession: penicillin; a B-vitamin complex; and a dewormer. In our survey, 84% of ranchers did not know the purpose of these medications. Rather, sick animals are given varied combinations of the three medications with no apparent rationale. Someone theoretically owns every horse on Rapa Nui. Some horse owners provide supplemental feed and deworming medications only to the fraction of their animals that they are currently using for work or pleasure; greater than 90% of horses range freely with virtually no supportive care. These animals are essentially feral.

Herd health education on Rapa Nui should start with promotion of the concept that it is preferable to have a healthy herd of modest size, than to have a huge herd of emaciated, debilitated animals. Though this may seem intuitive, ranchers typically derive more pride from the size of their herds than from the herd's health or productivity. Additionally, ranchers should be educated regarding selective breeding practices and appropriate use of prophylactic and curative medications in herd health. Another important issue is the obvious advantages of containment of animals rather than the current free-range practice. Maintenance of one's animals on a fenced property minimizes exposure to toxic plants, provides the opportunity for preventative and curative veterinary intervention, and allows provision of supplemental feed. Containment of livestock would be advantageous to animals and ranchers, and would have the additional benefit of decreasing environmental impact created by free ranging. Providing veterinary services only to ranchers that comply with limited range strategies could create an incentive for compliance with containment strategies. The author has already educated many ranchers regarding the health problems caused by toxic plants, but further efforts must be instituted to explain the pathophysiology and inevitably fatal course of *Crotalaria* intoxication.

2. *Plant Eradication*. Theoretically, the primary goal of the mitigation of *Crotalaria* toxicosis would be the eradication of *C. grahamiana* from Rapa Nui. (The introduction of *C. pallida* predates observation of PA-intoxicated animals by approximately 30 years so it's toxic effect is thought to be minimal.) Without efforts to eradicate *Crotalaria* from the island, the plant will surely continue to spread, resulting in progressive livestock suffering and subsequent environmental impact. The complete eradication of *cho cho* would be a tremendous undertaking, and may be impossible given the plant's opportunistic nature and the present extent of proliferation. In a best-case scenario, complete eradication would take several years and a multimodal approach.

Following a more practical abatement plan, priority regions from which to eradicate the plant would be identified. Areas where animals are most frequently seen grazing the plant (north portion of the Anakena road, Poike) and areas where the plant's spread is most aggressive (Rano Raraku access road and the interior of the Rano Raraku crater) would be targeted first. Plants would be uprooted when possible or cropped at their primary stem. Plant matter would be transported to a remote location for incineration. Each site would be revisited at 3-month intervals to remove new plants prior to seed formation. All work could be coordinated to minimize observation of the project by tourists. This selective abatement plan, combined with confinement of animals, would likely reduce the gross extent of intoxication.

Adjunctive methods would include introduction of alternative non-toxic plant species in the regions denuded of *cho cho* and/or the introduction of insect consumers with specific affinity for *Crotalaria*. Either of these plans would require careful evaluation for environmental impact prior to initiation.

3. *Improved water access.* It has been reported to the author that many well sites constructed by the Williamson Company are still patent and would require only pump motors to be functional. Five public access pump motors provided and installed with troughs at well sites at Akahanga, Hanga Oteo, Koreha, Vaitea, and Ovahe could significantly decrease roaming in search of water. In these regions, water access for animals is inadequate. This results in dehydration and subsequent roaming in search of water. Roaming exacerbates dehydration and causes ecological damage to precious archaeological sites, particularly in the Rano Raraku region. Dehydration results in decreased blood volume and increased concentration of toxins in the blood. Thus, providing public access to water will improve animal health and minimize environmental impact due to animal roaming and grazing.

4. *Supplemental Feed.* Horses and cattle on Easter Island are frequently allowed to roam free to graze. The practice of free range management and subsequent environmental impact could be discouraged by providing imported concentrated feed supplements. Preferably, efforts would be exerted to establish a cooperative to cultivate corn and alfalfa, eliminating the need to import feed supplements.

5. *Infectious Disease Screening and Control:* All cattle on the island should be screened routinely for tuberculosis via intradermal purified protein derivative (PPD) injection. Animals determined to be positive reactors should be euthanized and incinerated. This method has been utilized successfully to assess and eradicate TB from herds in several nations in Europe and North America. Without risk-assessment, tuberculosis among cattle represents a significant threat to animals, human natives, and tourists.

Toxoplasmosis is a protozoal disease of humans and domestic animals. The greatest threat of this disease is the potential to cause human abortion and birth defects. Humans commonly contract the disease from the feces of cats. An epidemiological study should be instituted to determine prevalence and risk factors for toxoplamosis among cats and humans on Rapa Nui.

Intestinal parasites (worms and bots) are ubiquitous among the horses, cattle, dogs, and cats of Rapa Nui. Larval forms of some of these parasites may infect humans and burrow through various tissues. All parasites impair animal welfare and production. Widespread application of antiparasitic medications will improve animal health and decrease parasite load of the environment. Thus, further infection of animals and humans will be minimized.

6. *Reproductive Management*. Cattle and horses on Rapa Nui exist in quantities greater than can be sustained by current

natural resources and management practices. This is the most practical definition of overpopulation. Though it is more difficult to assess whether small animals on the island are overpopulated, cats and dogs breed recklessly with excessive morbidity and mortality resulting from neglect and malnutrition. As the vast majority of all domestic species on the island enjoy free-range conditions, there is essentially no control of reproduction. Managed reproduction of domestic species requires appropriately timed matings between reproductively intact animals and sterilization of animals whose offspring are not specifically desired.

The growth of a population of free-range animals is more dependent on the number of reproductively sound females than males. This is because the number of breeding females is more of a limiting factor. A single stallion could, theoretically, impregnate an entire herd of mares. This is unfortunate for herd managers because surgical castration is a simple procedure whereas surgical hysterectomy (spay) traditionally requires general anesthesia and intra-abdominal surgery. As with the toxic plant problem, education is a major part of the solution to the problem of unchecked breeding and overpopulation. Recognition that animals of any species should not be allowed to breed freely is the first step towards population control. Cat and dog populations could be more easily controlled than horses and cattle because in these species castration and spay are relatively straightforward procedures.

Breeding, in a managed livestock herd is typically controlled by maintaining a herd of mares (or cows) with guildings (or steer). Stallions (or bulls) are allowed access to only the females that are selected for breeding and only during breeding times determined by the rancher or herd manager. An intrinsic necessity of this plan is physical separation of reproductively intact females from males. On Rapa Nui, this is problematic because of the well-established notions of free ranging of livestock species. The incentives of free or low cost veterinary care and supplemental feed and water could be used to encourage responsible breeding practices.

Immunocontraception is an alternative method of population control that would have distinct advantages on Rapa Nui. The porcine zona pellucida (PZP) vaccine has been utilized successfully for contraception among feral horses in Nevada and on several barrier islands off the eastern cost of the United States. The vaccine stimulates an immune response against the outer layer of an ovulated egg and thus prevents fertilization by sperm. The greatest advantage of PZP contraception is that it would be effective regardless of physical separation of male and female animals. The vaccine is easily administered by syringe or dart gun and has efficacy of greater than 90%. Additionally, vaccines are being developed using sperm antigens that would be effective contraceptives in males or females.

Culling (selective euthanasia) is also an important part of herd health, and is much needed on Rapa Nui. Indications for culling are incurable illness, overpopulation, advanced age, and poor genetic stock. Culling is rarely performed on Rapa Nui largely due to the notion that owning more animals is better regardless of the animals' condition.

7. *Ambulatory veterinary services.* A fundamental need of animal owners on Rapa Nui is appropriate diagnosis and treatment of routine diseases of their livestock and small animals. A substantial portion of animal morbidity could be prevented by routine health screenings, prophylactic deworming and early diagnosis. These services are unavailable on Rapa Nui and might be cost prohibitive if they were offered through a conventional clinic. An essential part of this comprehensive plan would be to provide free ambulatory veterinary services for small animal and livestock owners. Such services would also allow frequent communication with, and education of ranchers regarding the issues of reproductive management and preventative medicine and could be used as an incentive to adhere to recommendations regarding herd size and confinement of animals.

CONCLUSION

In a typical one-hour drive through the backcountry of Rapa Nui it is common to encounter at least one emaciated horse stumbling among rocks in a confused stupor. Dogs are malnourished and frequently seen limping or with open wounds Human inhabitants are unaware of the perils of contracting potentially fatal infectious diseases and toxicities. In our age of modern veterinary medicine and awareness of animal welfare, it is intolerable to allow this to continue. Animals are suffering, irreplaceable archeological sites are being destroyed, and tourists are beset with the notion of an antiquated land where animal welfare is disregarded. The plans outlined above are beneficial to all interested parties including livestock owners, national park managers, archaeologists, and tourism-dependant businesses. The investment in this work is justified by the proposed mitigation of animal suffering, the importance of the preservation of the heritage of Rapa Nui, and the existence of significant threats to human public health. The author is presently engaged in raising funds to initiate programs based on the proposals outlined herein.

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